From: Smithsonian
Published September 19, 2007 10:44 AM

New study shows fish respond quickly to changes in mercury deposition

Reducing atmospheric mercury emissions should quickly reduce mercury levels in lake fish, according to a three-year study published this week in the Proceedings of the National Academy of Science. The study showed that an increase in mercury loading at rates relevant to atmospheric deposition resulted in a significant increase in methylmercury production and accumulation in fish in only three years.
“This is good news. It means that a reduction in new mercury loads to many lakes should result in lower mercury in fish within a few years,” said Cynthia Gilmour, scientist at the Smithsonian Environmental Research Center and a co-investigator in the study.

While recent federal and state regulations aimed at reducing mercury levels in fish require reductions in mercury emissions, the potential effectiveness of these controls and the time frame of the response were previously unknown.
Some have speculated that it could take decades to see the impact of emissions reductions on mercury levels in fish. Centuries of human-derived mercury releases to the atmosphere have resulted in elevated amounts of mercury in sediments and soils across most of the globe. If this historical mercury contamination contributes substantially to mercury in fish, reductions in current emissions may have little impact in the foreseeable future.
The study, “Mercury Experiment to Assess Atmospheric Loading in Canada and the United States,” found that methylmercury (the type that accumulates in fish) was more readily produced from newly deposited mercury than from historical mercury contamination already buried in lake sediments. This means that methylmercury in lakes should decline quickly if mercury deposition is reduced.
Additionally, the study team found that mercury added directly to the lake surface was rapidly accumulated into fish, while essentially none of the mercury deposited to the lake’s watershed was found in fish after three years. This suggests that lakes should exhibit a two-phase response to load reductions. Initially, mercury in fish should decline rapidly (within years) as deposition to the lake itself is reduced. A slower, more prolonged decline (perhaps decades long) should follow in response to decreases in mercury deposition in the watershed.
The study was accomplished through an experimental addition of mercury to a small lake and its watershed at the Experimental Lakes Area, a Canadian federal research reserve. ELA is a remote, protected area set aside for the long-term study of lakes and watersheds, where deposition of mercury is low compared with sites in Europe and the United States. For three years, the mercury load to the lake ecosystem was increased by roughly three times—bringing the total annual mercury load up to a level comparable to that on the east coast of the United States. This large-scale, whole ecosystem approach was important because the complex behavior of ecosystems can be difficult to predict from smaller-scale experiments.
To distinguish the mercury they added to the lake from the existing mercury in the study ecosystem, the

researchers used a sophisticated analytical method that had never been used in this way at such a large scale. Mercury in the natural environment is made up of seven stable isotopes that do not vary much in proportion to one another. To dose the lake, the scientists used mercury that is heavily enriched in one of those isotopes, enabling them to trace the mercury they added through the complex environmental mercury cycle.

Gilmour and her colleagues Andrew Heyes (University of Maryland) and Robert Mason (University of Connecticut) focused on one of the key processes in that cycle, the microbial production of methylmercury, which is produced by natural bacteria in sediments and soils and accumulates in food webs.

"It will be important to monitor mercury during the next 20 years to make sure that emissions regulations are effective in reducing mercury deposition," Gilmour said. "If they are, the study suggests that reductions in emissions will result in fairly rapid reduction in risk to people and to ecosystems."

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